

THAT WHICH IS CLAIMED:

1. An apparatus for joining multiple pieces of thermoplastic material to form a cellular block, comprising:

at least one welding mechanism for welding the pieces to the cellular block; and

a supplying mechanism for successively supplying to the welding mechanism the pieces to be welded to the cellular block, by arranging each piece to be welded to the cellular block in opposing face-to-face relation with the piece most recently previously welded to the cellular block,

wherein the welding mechanism welds the piece to be added to the cellular block and the piece most recently previously welded to the cellular block by contemporaneously forming multiple spaced apart and elongate welds between the piece to be added to the cellular block to the piece most recently previously welded to the cellular block, each of the welds extends in a longitudinal direction, the welds are spaced apart from one another in a lateral direction, and the welding mechanism includes a rolling mechanism that engages and rolls in the longitudinal direction across at least one of the piece to be added to the cellular block and the piece most recently previously welded to the cellular block to provide a plurality of rolling contact regions that form the welds.

2. An apparatus according to claim 1, wherein the longitudinal direction is generally upright.

3. An apparatus according to claim 1, wherein the rolling mechanism is mounted for reciprocating in the longitudinal direction.

4. An apparatus according to claim 1, wherein the rolling mechanism is mounted for reciprocating in the lateral direction.

5. An apparatus for joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

a supplying mechanism including at least one station mounted for repeatedly traveling along a path to a position proximate a plurality of welding mechanisms for welding the cut pieces together to form the cellular block, wherein the station includes a plurality of protrusions for repeatedly engaging and carrying cut pieces along the path to proximate the welding mechanisms, and the welding mechanisms are mounted for respectively moving in slots defined between adjacent protrusions of the plurality of protrusions while the station is proximate the plurality of welding mechanisms.

6. An apparatus according to claim 5, wherein the plurality of welding mechanisms includes a plurality of welding rollers for engaging and rolling across the cut pieces.

7. An apparatus according to claim 5, wherein the welding mechanisms are mounted for reciprocating in the slots.

8. An apparatus according to claim 5, wherein at least some of the protrusions each include a least one port at which a partial vacuum is supplied to facilitate the carrying of the cut pieces by the station.

9. An apparatus for joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

a supplying mechanism for supplying the cut pieces;

a forming mechanism where the cut pieces are sequentially received and welded together to form the cellular block; and

a carrying mechanism mounted for translating between the supplying mechanism and the forming mechanism, and including at least one station that is operative for receiving at least one of the cut pieces from the supplying mechanism, carrying the cut piece from the supplying mechanism to the forming mechanism while the carrying mechanism translates, and supplying the cut piece directly to the forming mechanism.

10. An apparatus according to claim 9, wherein the station includes a plurality of ports at which a partial vacuum is supplied to facilitate the carrying of the respective cut piece by the station.

5 11. An apparatus according to claim 9, wherein the carrying mechanism is mounted for reciprocating toward and away from the forming mechanism.

12. An apparatus according to claim 11, wherein the carrying mechanism is mounted for reciprocating is least generally horizontally.

13. An apparatus according to claim 11, wherein the carrying mechanism is mounted for:

10 reciprocating in a first direction between first and second positions that are respectively relatively closer to and farther from the forming mechanism, and reciprocating in a second direction that is substantially perpendicular to the first direction.

14. An apparatus according to claim 9, wherein:
15 the station includes a plurality of pairs of protrusions that extend radially with respect to the axis,
slots are defined between the protrusions of each pair, and
the forming mechanism includes a plurality of welding mechanisms that are for welding the cut pieces together and are respectively received in the slots.

20 15. An apparatus according to claim 14, wherein the pairs of protrusions of the second station are laterally offset from the pairs of protrusions of the first station in the direction of the axis.

16. A method of joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

25 a) positioning a cut piece being added to the cellular block in opposing face-to-face relation with a cut piece most recently previously added to the cellular block;

b) heating, to the welding temperature of the cut pieces, first strips which are opposite one another on surfaces of the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block;

5 c) pressing together the surfaces of the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block, so that the first strips of the cut piece being added to the cellular block and the first strips of the cut piece most recently previously added to the cellular block respectively meet and thereby the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block are thermally fused together, and the cut piece being added to
10 the cellular block becomes the cut piece most recently previously added to the cellular block;

d) positioning a cut piece being added to the cellular block in opposing face-to-face relation with the cut piece most recently previously added to the cellular block;

15 e) heating, to the welding temperature of the cut pieces, second strips which are opposite one another on the surfaces of the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block, wherein the second strips are laterally spaced apart from the first strips;

20 f) pressing together the surfaces of the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block, so that the second strips of the cut piece being added to the cellular block and the second strips of the cut piece most recently previously added to the cellular block respectively meet and thereby the cut piece being added to the cellular block and the cut piece most recently previously added to the cellular block are thermally fused together, and the cut piece being added to the cellular block becomes the cut piece most recently previously added to
25 the cellular block; and

g) (a) through (f) are continuously repeated with many further cut pieces.

17. A method according to claim 16, further comprising heating the cellular block to the point of plastic deformation and expanding the cellular block in the production direction to convert the cellular block into honeycomb material.

18. A method of joining multiple pieces of thermoplastic material to form a cellular block, comprising:

arranging first and second pieces of the thermoplastic material in opposing face-to-face relation; and

5 then welding the first and second pieces together by engaging a rolling mechanism against, and at the same time rolling the rolling mechanism across, at least one of the first and second pieces to provide a plurality of spaced apart rolling contact regions that at least partially form a plurality of spaced apart nips that travel in a longitudinal direction to form multiple spaced apart and elongate first welds between the first and second pieces,
10 so that the first welds extend in the longitudinal direction.

19. A method according to claim 18, wherein each of the first and second pieces include nonwoven thermoplastic fabric.

20. A method according to claim 18, wherein the rolling a rolling mechanism includes rolling a plurality of rollers that are spaced apart from one another in a lateral
15 direction that is generally perpendicular to the longitudinal direction.

21. A method according to claim 18, wherein the nips are defined between the rolling mechanism and a welding mechanism that is opposed to the rolling mechanism.

22. A method according to claim 18, further comprising:
arranging the second piece and a third piece of the thermoplastic material in
20 opposing face-to-face relation after welding the first and second pieces together; and
then welding the second and third pieces together by contemporaneously forming multiple spaced apart and elongate second welds between the second and third pieces, wherein each of the second welds extends in the longitudinal direction, the second welds are offset from the first welds in a lateral direction that is at least generally perpendicular
25 to the longitudinal direction, and the welding of the second and third pieces together includes rolling the rolling mechanism across at least one of the second and third pieces in the longitudinal direction.

23. A method according to claim 22, wherein:

the nips that form the first welds are defined between the rolling mechanism and a first welding mechanism; and

5 the forming the second welds includes nipping the second piece and the third piece between the rolling mechanism and a second welding mechanism.

24. A method according to claim 23, further comprising moving the rolling mechanism laterally after forming the first welds and before forming the second welds.

25. A method for joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

10 supplying at least one cut piece to be added to the cellular block by engaging a plurality of spaced apart protrusions to the cut piece to be added to the cellular block and moving the protrusions along a path so that the protrusions carry the cut piece to be added to the cellular block along the path to a position proximate the cellular block; and

15 then welding the cut piece to be added to the cellular block to a cut piece most recently previously welded to the cellular block, including moving a plurality of welding mechanisms respectively within respective slots defined between adjacent protrusions of the plurality of protrusions, and engaging the welding mechanisms against the cut piece to be added to the cellular block.

20 26. A method according to claim 25, wherein the moving the protrusions along the path includes translating the protrusions.

27. A method of joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

arranging a cut piece to be welded to the cellular block in opposing face-to-face relation with a cut piece most recently previously welded to the cellular block;

25 then welding the cut piece to be welded to the cellular block and the cut piece most recently previously welded to the cellular block together by contemporaneously

forming multiple spaced apart and elongate first welds therebetween, wherein the welding includes:

contemporaneously moving a plurality of welding mechanisms and a plurality of heating elements along opposite sides of the cut piece to be welded to the cellular block during the opposing face-to-face relation,

heating at least one of the cut piece to be welded to the cellular block and cut piece most recently previously welded to the cellular block with the heating elements,

then nipping the cut piece to be welded to the cellular block and the cut piece most recently previously welded to the cellular block between the plurality of welding mechanisms and structure to weld the together the cut piece to be welded to the cellular block and cut piece most recently previously welded to the cellular block to thereby form a plurality of cells in the cellular block; and

continuously repeating the arranging and welding.

28. A method according to claim 27, wherein the cut piece to be welded to the cellular block and the cut piece most recently previously welded to the cellular block each include nonwoven thermoplastic fabric.

29. A method according to claim 27, wherein the plurality of welding mechanisms is a first plurality of welding mechanisms, the structure includes a second plurality of welding mechanisms and a third plurality of welding mechanisms, and the nipping alternately includes:

nipping between the first and second pluralities of welding mechanisms, and

nipping between the first and third pluralities of welding mechanisms.

30. A method of joining multiple cut pieces of thermoplastic material to form a cellular block, comprising:

moving a carrying mechanism so that the carrying mechanism carries at least a first cut piece to proximate the cellular block;

welding the first cut piece to the cellular block, including forming a first plurality of longitudinally extending welds that are laterally spaced apart from one another;

releasing the first cut piece from the carrying mechanism;

5 moving the carrying mechanism so that the carrying mechanism carries at least a second cut piece to proximate the cellular block;

welding the second cut piece to the cellular block;

moving the carrying mechanism laterally prior to welding the second cut piece to the cellular block, so that the welding the second piece includes forming a second plurality of longitudinally extending welds that are laterally spaced apart from one another, and the first and second plurality are laterally spaced apart from one another;

10 releasing the second cut piece from the second station.

31. A method according to claim 30, wherein the first and second cut pieces include nonwoven thermoplastic fabric.

32. A method according to claim 30, further comprising expanding the cellular block by pulling the cellular block in a direction that is at least generally perpendicular to the longitudinal direction.

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33. A method according to claim 30, wherein the welding the first cut piece includes maintaining the first cut piece in at least a generally upright orientation during the welding of the first cut piece, and the welding the second cut piece includes maintaining the second cut piece in at least a generally upright orientation during the welding of the second piece.

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34. A method according to claim 30, further comprising:

moving the carrying mechanism so that the first station is proximate a transfer position and then transferring the first cut piece to the first station prior to moving the carrying mechanism so that the first station carries the first cut piece; and

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moving the carrying mechanism so that the second station is proximate a transfer position and then transferring the second cut piece to the second station prior to moving the carrying mechanism so that the second station carries the second cut piece.

35. A method according to claim 30, wherein:

5 the welding the first cut piece to the cellular block includes contemporaneously forming multiple spaced apart and elongate first welds, which extend in a longitudinal direction, between the first cut piece and a cut piece that was most recently previously welded to the cellular block; and

10 the welding the second cut piece to the cellular block occurs after the welding the first cut piece to the cellular block and includes contemporaneously forming multiple spaced apart and elongate second welds, which extend in the longitudinal direction, between the first cut piece and the second piece, so that the second welds are offset from the first welds in a lateral direction.

15 36. A method according to claim 35, wherein the forming the first welds includes respectively aligning a first plurality of welding mechanisms, which are laterally spaced apart from one another, with a second plurality of welding mechanisms, which are laterally spaced apart from one another, and then nipping the first cut piece and the cut piece most recently previously welded to the cellular block between the first and second pluralities of welding mechanisms.

20 37. A method according to claim 36, wherein the nipping includes rolling the welding mechanisms of the first plurality along the first cut piece in the longitudinal direction so that there is rolling contact between the welding mechanisms of the first plurality and the first cut piece.

25 38. A method according to claim 36, further comprising moving the first plurality of welding mechanisms laterally with respect to the second plurality of welding mechanisms, and wherein the forming the second welds includes nipping the first cut piece and the second cut piece between the first plurality of welding mechanisms and a

third plurality of welding mechanisms that are laterally spaced apart from one another and respectively aligned with the welding mechanisms of the first plurality while the second welds are formed.

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